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# PATENT SPECIFICATION

DRAWINGS ATTACHED

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## COMPLETE SPECIFICATION

## Device for Opening Filaments

We, KURASHIKI RAYON KABUSHIKI KAISHA of No. 1621, Sakazu, Karashiki City, Japan, a company organized according to the laws of Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a device for opening crimped continuous filament tow.

In order to pass smoke through a cigarette filter uniformly it is preferable to use bulky filament tow without small bundles of filaments due to cohesion of filaments. This is especially true in the case of a powder adhesive product, wherein adhesive powders are dispersed in the filament tow and after being formed into a cigarette filter the adhesive powders are dissolved by treatment with a solvent, thereby creating adhering points among the filaments, and it is particularly necessary that the filament tow should be broad and well opened. There are two or three known processes for opening continuous filament tows. In a known rolling process there is the disadvantage that small bundles of filaments are left, and an air blowing process or high speed vibration process is liable to cause deviation of fibres and also to destroy or reduce the crimps of fibre due to violent opening. Moreover, known devices cannot satisfactorily operate to make a filament tow to broad band shape so that they are not usable as devices for opening filament for cigarette filters, more particularly as devices applicable to powder adhesive processes.

The present invention provides a device for opening a crimped continuous filament tow, which device comprises a pair of back rollers and a pair of front rollers, means for passing the filament tow between the pairs of rollers so that the filament tow is in a state of tension between the two pairs of rollers and a porcupine roller whose needles are so positioned as to penetrate the filament tow between the said two pairs of rollers, and means for driving the pair of back rollers, the pair of front rollers and the porcupine roller at peripheral speeds in the ratios 1:1.2 to 2.0:0.65 to 0.82.

The present invention also provides a method of opening a crimped continuous filament tow, which method comprises passing the continuously travelling filament tow between a pair of back rollers and subsequently between a pair of front rollers so that the filament tow is in a state of tension between the two pairs of rollers, penetrating the filament tow between the said two pairs of rollers with needles of a porcupine roller, and driving the pair of back rollers, the pair of front rollers and the porcupine roller at peripheral speeds in the ratios 1:1.2 to 2.0:0.65 to 0.82. The filament tow may be passed successively through at least two of the devices defined above.

Now the opening device of the invention will be explained with reference to the accompanying drawing, in which a single figure is a diagrammatic representative of a device embodying the invention.

The essential parts of the present device consist of a pair of back rollers 1, 1′, a pair of front rollers 2, 2′, a porcupine roller 3, a tension roller 4, a feed roller 5, a feed leather in the form of an endless belt 6 and several middle rollers 7 arranged as shown in the drawing.

The device shown is operated as follows:— The filament tow 8 is taken up by the tension roller 4 to pass between a pair of back rollers 1,1′ and is spread on the feed leather by means of middle rollers 7 and acted upon by the porcupine roller 3 then passed between the front rollers 2 and 2′ and as the opened filament tow passes over the feed

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roller 5. The back rollers 1, 1', front rollers 2, 2' and porcupine roller 3 are driven by a driving means (not shown) such as cooperating gear wheels having different number of teeth or cooperating belts, making the peripheral speed of front rollers 2, 2' greater than that of the back rollers 1, 1' and the ratio of 1:1.2 to 2 so as to give a draft to the filaments while passing through the mechanism and the peripheral spread of the porcupine roller 3 is so adjusted to give a draft, i.e. slackening effect in the ratio of 1: 0.65 to 0.82 to the peripheral speed of the back rollers 1, 1' by slowing down its peripheral speed. The filament tow is subjected to a crosswise force by the continuous repetition of tensing and slackening and is opened thereby and moreover is combed by the needles of the porcupine roller 3 so that small bundles of filaments disappear and the widened breadth of the filament tow is retained so that uniform force is transmitted to all parts of the tow, thereby avoiding deviation of filaments to provide a uniform open state. The feed leather and middle rollers 7 cooperate to assist the travel of the filament tow and prevent the disturbance of filaments in between the back rollers 1, 1' and the front rollers 2, 2' and also prevent the lifting of the filament by the porcupine roller 3 and operate to spread the filament tow crosswise.

It is necessary for the porcupine roller that its needles penetrate the filament tow and the length, diameter and intervals of the needles should be determined, in connection with the peripheral speed, so as not to break down the filament and stretch crimps. Each needle is thin and penetrates a short distance through the filament tow in order to prevent the breaking of filaments.

Each of the different rollers of the device may be driven by an independent device, or they may be driven through gear wheels having different numbers of teeth, the combination thereof being made adjustable, or by belts having different diameters of driving shafts. Then the draft between the sets of rollers can be easily determined within the ratios previously stated corresponding to the change of deniers and condition of the filament tow, and the peripheral speed of the rollers can be conveniently changed, so that it is preferred that all the rollers be driven from a common drive. As understood from the foregoing description the device of the invention has the great advantage that the operating speed can be increased since the filament tow is opened during its continuous travelling by the difference of speeds between rollers and porcupine roller, and the opening operation can be performed continuously, positively and quickly without giving intermittent or non-uniform motion of the rollers.

The opening device of the invention can provide a satisfactory open condition to the filament tow by passing it through the mechanism as shown in the drawing, and according to the condition of the filament tow and special purpose two sets of the device as shown may be used in combination to open the filaments successively in two zones. In such a case, the tension can be changed at a position between the first and second zones. For instance, the drafts between the front rollers 1, 2' and back rollers 1, 1' and between the back rollers 1, 1' and porcupine roller 3, are determined to a suitable value respectively for both of the first and second zones.

WHAT WE CLAIM IS:—

1. Device for opening a crimped continuous filament tow, which device comprises a pair of back rollers and a pair of front rollers, means for passing the filament tow between the pairs of rollers so that the filament tow is in a state of tension between the two pairs of rollers and a porcupine roller whose needles are so positioned as to penetrate the filament tow between the said two pairs of rollers, and means for driving the pair of back rollers, the pair of front rollers and the porcupine roller at peripheral speeds in the ratios 1:1.2 to 2.0: 0.65 to 0.82.

2. Device for opening a crimped continuous filament tow substantially as hereinbefore described with reference to, and as illustrated in, the accompanying drawing.

3. A method of opening a crimped continuous filament tow, which method comprises passing the continuously travelling filament tow between a pair of back rollers and subsequently between a pair of front rollers so that the filament tow is in a state of tension between the two pairs of rollers, penetrating the filament tow between the said two pairs of rollers with needles of a porcupine roller, and driving the pair of back rollers, the pair of front rollers and the porcupine roller at peripheral speeds in the ratios 1:1.2 to 2.0: 0.65 to 0.82.

4. A method as claimed in claim 3, wherein the filament tow is passed through the device claimed in claim 1 or claim 2.

5. A method as claimed in claim 4, wherein the filament tow is passed successively through two of the devices claimed in claim 1 or claim 2.

6. Filter-tips when prepared from a crimped continuous filament tow which has been opened in the device of claim 1 or claim 2 or by the method of any one of claims 3 to 5.

MARKS & CLERK
Chartered Patent Agents
Agents for the Applicant(s)

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vertically disposed arrows in Fig. 1 illustrate the reciprocating motion of the striker 19 under the impulse from reciprocating mechanism 17. The striker moves against and contacts the tow normal to the tow movement path. In its uppermost position, the striker does not contact the tow, but in the downward stroke contact is made and in the lowermost position of the striker 19 the tow is deflected from its normal path through the tension zone. Most advantageously the amount of deflection caused by the striker is sufficient to impart an additional stretch of the order of approximately 8% to the tow. In order to accomplish this more easily, stationary anvils 20 and 21 are positioned along the tow path on the opposite side thereof from the reciprocating mechanism. The spacing of the anvils relative to each other and to the rolls is not critical. The purpose of the anvils being merely to reduce the amount of total deflection, i. e. striker stroke length necessary to impart the desired additional increment of tension to the tow. Preferably the anvils are positioned so that they themselves do not deflect the tow path. It is preferred also that they be so disposed that the striker path will be midway between them whereby to avoid side thrust on the striker.

I have found it advantageous in working with a crimped cellulose acetate tow to reciprocate the striker approximately 3 inches per stroke with about 3,500 strokes per minute. The rate of receprocation, like the stroke length, is quite variable and normally will be satisfactory if maintained in the range of 1,800 S. P. M. to 5200 S. P. M., S. P. M. meaning downward strokes per minute. An essential requirement seems to be that the strokes be made rapidly enough to set up a condition which may be termed a "vibrational effect." As another criteria it may be said that with the tow moving through the device at a rate of the order of about 10 to 1700 feet per minute, the strokes of the striker should be of a high enough order so that not more than about 50 crimps pass under the striker between strokes. Preferably, far fewer, e. g. not more than about 5 crimps should pass under the striker between strokes.

An apparatus embodying the invention is illustrated in Fig. 2 wherein is shown a frame 22 supporting a pair of driven rolls 23 and 24. This pair together with a pair of retarded rolls 25 and 26 form a path for tow passing between the bites thereof. The two pairs also serve to provide therebetween a tow tensioning zone. The rolls are all provided with elastic surfaces whereby, with close spacing of the rolls of each pair, a positive grip on the tow is obtained and slippage of the tow through the bite of the rolls is reduced to a minimum.

The rolls 23 and 24 are positively driven in the direction indicated by arrows thereon by means of a motor 28, and the rolls 25 and 26 are driven at a slower speed through a variable speed transmission 29.

A means for intermittently applying an additional increment of tension by sudden application and release in rapid cycles comprises pneumatic reciprocator 30 and a striker element 31 carried by a reciprocating rod thereof. The striker 31 is driven to make approximately 3,500 strokes per minute across the tow path into a region between two spaced anvils 32 and 33 having smooth rounded working faces 34 and 35 respectively lying in a plane parallel to and adjacent the tow path. The working faces of the anvils, as well as the bottom of the striker, should be rounded and sufficiently smooth and polished to avoid cutting the filaments. Equally important is the requirement that these surfaces not substantially impede the movement of tow across them. In other words, there should be enough slippage and sliding that forces applied to tow between the anvils will be felt for the full length of the tow in the tension zone.

With reference to Fig. 3 it will be seen that the striker 31 is of a width necessary to provide ample bearing surface for the tow and that when the striker is in a position above the tow path there is ample clearance for passage of the tow along its normal route between the bites of the two roll pairs.

The invention is operative with crimped continuous filament tows in general so long as the filaments of the tow meet the general requirements of sufficient strength to prevent breakage and an absence of permanent elongation under the tension necessary to achieve the purpose of the invention. It is obvious that the filaments must have an inherent urgency to return to their normal length and crimped condition when tension is removed. The invention is useful with crimped tows of cellulose acetate, saponified cellulose acetate, and regenerated cellulose, and crimped tows of acrylic, polyester, polyamide and protein type filaments. Tows varying in size from 500 to 5,000,000 filaments of 1.0 to 50 or more denier per filament may be opened by means of the invention. The operating range of crimp will vary with the type fiber and its denier per filament. For instance, with a cellulose acetate tow of 2 D./F. the crimp would be in the order of 12 to 14 crimps per inch; for 10 D./F. to 8 crimps per inch; and for 50 D./F., 3 to 4 crimps per inch.

While the illustrated retarded rolls are positively driven, e. g. at preferably 99.5% of the speed of the tension rolls, they may be retarded merely by a frictional braking effect such as results from such close spacing of the retarded rolls that substantial work must be done to overcome the friction in flexing of the elastic roll surfaces. The invention is illustrated in the following example.

*Example 1*

A tow of 5 denier per filament and 100,000 total denier was formed with the products from a number of spinning cabinets. The tow was lubricated with a special pharmaceutical grade of mineral oil. A crimp of 7.0 crimps per inch was applied to the tow which was then dried and sent to a ball warping machine where it was wound on a fiber tube. The ball warp package thus prepared was used as a supply to a cigarette filter machine such as disclosed in Crawford and Stevens U. S. application S. N. 374,168 filed August 14, 1953. Upon being removed from the ball warp the tow was immediately run through an opening device embodying the instant invention and the filter plugs resulting from the cellulose acetate filaments so processed were found to be greatly improved in regard to fiber distribution and absence of channeling of the smoke as well as in the respect that the filters were firm and resilient.

The basic concept of this invention may be adapted for use with a wide variety of filamentary materials under varying conditions. Thus, the apparatus of the invention may find a number of different and varying embodiments. For example, the means for applying an additional increment of tension may be used satisfactorily in combination with a tension roll device wherein the retarded rolls are dispensed with and their function is supplied solely by means of a tow source, e. g., a ball warp, which is frictionally braked or unwound through a power drive at a speed sufficiently less than, e. g. 99.5% of that of the draw of the power driven tension rolls.

Furthermore, while the striker and anvil arrangement has been described in terms of "vertical" reciprocation, "uppermost" and "lowermost" positions and "downward" stroke, horizontal alignment of the striker and anvil arrangement proves equally satisfactory, as does also an arrangement providing for upward tensioning strokes by the striker.

I claim:

1. Means for opening a crimped continuous filament tow comprising a pair of spaced means forming a path for moving tow therebetween, the means including a front means adapted to continuously pull tow along the path under tension and a back means adapted to continuously exert a holding force on the tow while allowing the tow to pass due to a greater force exerted by the front means, a first anvil positioned between the front

and back means and providing a working face immediately adjacent to the tow path, a second anvil positioned between the first anvil and the front means, spaced from the first anvil and providing a working face immediately adjacent to the tow path, a reciprocating striker positioned for operation on the opposite side of the tow path from the anvils and disposed to operate in a plane between the anvils normal to the tow path and to the plane of the working faces of the anvils, and means for rapidly reciprocating the striker to supply an additional increment of tension to the tow in suddenly applied and suddenly released cycles, the reciprocating striker being adapted in one extreme position to deflect the tow path by carrying it into a position between the anvils and in the other extreme position to stand free of the tow path on the side opposite the anvils.

2. Method for opening crimped continuous filament tow comprising applying a first amount of tension to the tow sufficient to substantially straighten out the crimps therein, while the tow is thus tensioned periodically applying a suddenly imparted and suddenly released additional increment of tension, and thereafter suddenly releasing the tow from the first amount of tension.

3. Method as defined in claim 2 wherein the tow is continuously moved in a longitudinal direction along a fixed path and the tension is applied in a fixed tension zone forming a part of the path.

4. Method as defined in claim 3 wherein the additional increment of tension is of an order which will result in about an 8% additional stretch in the tow.

5. Method for opening crimped continuous filament tow comprising longitudinally moving the tow successively through spaced pairs of gripping rolls defining a tension zone therebetween, intermittently additionally stretching the tow while it is under tension in the tensioning zone, and suddenly discharging the tensioned tow from the tensioning zone into a zone of relative relaxation.

6. An improved method for continuously opening a running length of crimped continuous filament tow, said method including the steps of (1) applying a constant predetermined longitudinal tension to the moving tow in a zone between a first pair of fixed points in the path of the tow, the predetermined tension being sufficient to temporarily remove some but not all of the crimp from the tow, (2) while the tow is under said tension intermittently applying an additional amount of tension to the tensioned moving tow between a second pair of fixed points in the path of tow between the first pair of fixed points, the rate of application of the intermittently applied additional tension being such that it is applied along the tow at least once in every 10 crimp lengths of tow, and (3) finally discontinuing the application of the intermittently applied tension and at the same time suddenly removing substantially all of said constant predetermined tension.

7. Method for opening crimped continuous filament tow comprising moving the tow longitudinally through a tension zone between a pair of retarded rolls and a pair of driven tension rolls spaced downstream from the retarded rolls, while the tow is in the tension zone applying to it a first amount of tension necessary to substantially straighten out the crimps in the tow, simultaneously subjecting the tow to an intermittent suddenly applied and released additional tension, and maintaining the tension on tow discharged from the driven tension rolls at a value substantially less than the first amount of tension to which the tow is subjected in the tension zone.

8. Improved tow opening apparatus comprising a cooperating pair of positively driven tensioning rolls providing a bite for tow passed therebetween, a cooperating pair of frictionally braked idler rolls providing a bite for tow passed therebetween, the braked rolls being spaced from the tensioning rolls and arranged in cooperation with the tensioning rolls to form a path for longitudinal movement of continuous filament tow into and through the bite of the braked rolls, thence into and through the bite of the tensioning rolls, means for removing at a relatively reduced tension tow discharged from the bite of the tensioning rolls, and a reciprocating striking means positioned adjacent the tow path between the braked rolls and the tensioning rolls, the striking means being adapted to strike tow in a direction normal to its movement at regulated intermittent intervals and to thus suddenly stretch and suddenly release the tow in accordance with reciprocating movement of the striker, said braked rolls having elastic surface portions and being positioned sufficiently close to each other that the elastic surface portion of each is deformed by the force exerted against it by the opposed cooperating roll, whereby work done in flexing the roll surface portions as the rolls turn provides a braking force on the rolls.

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1068384 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*